CLAIMS

1. An apparatus for monitoring a vascular access associated to an extracorporeal blood circuit, comprising:

- at least a first pump (9, 16) predisposed for circulation of a fluid in at least one of the extracorporeal blood circuit and an at least one fluid transport line (15) cooperating with the circuit;
- a memory, containing a mathematical model of the vascular access (6) comprising:
  - o at least a first parameter relating to at least one characteristic (R_d, R_f, R_v, q_a, q_f, q_v) of the vascular access;
  - o at least a second parameter relating to at least one characteristic (P) of the blood; and
  - o at least a third parameter relating to a flow rate (q_b, q_{uf}) of the fluid moved by the first pump (9; 16);
- a control and calculation unit (17) connected to the memory and to the first pump (9, 16) and programmed to perform a monitoring procedure which comprises the following operating stages:
  - o varying the flow rate of the first pump (9; 16);
  - o receiving the signals corresponding to the values (P_{af}, P_{am}, P_{vf}, P_{vm}) assumed by the characteristic (P) of the blood in at least one zone of the blood circulation path and with at least two different values of the flow rate (q_b, q_{uf}) of the first pump (9; 16);
  - o storing in memory the values of the characteristic of the blood and the corresponding values of the flow rate of the first pump (9; 16);
  - o processing the values stored in memory by means of the mathematical model, in order to determine at least one

value of the characteristic of the vascular access.

2. The apparatus of claim 1, wherein the second parameter relates to a physical property or a chemical property or a chemical-physical property of the blood which property has a correlation with the blood flow rate, the mathematical model describing the correlation.

3. The apparatus of claim 1, wherein the mathematical model describes a relationship between the difference of the said characteristic (P) of the blood at two points of the intracorporeal blood circulation path and the blood flow rate flowing between the said two points.

4. The apparatus of claim 1, wherein the first parameter is relative to at least one fluid-dynamic characteristic of the vascular access, the mathematical model being a fluid-dynamic model of the vascular access.

5. The apparatus of claim 1, wherein the said at least one value of the characteristic of the vascular access is determined by calculating at least one solution of the said mathematical model.

6. The apparatus of claim 5, wherein the optimal solution of the said mathematical model is calculated.

7. The apparatus of claim 1, wherein the fluid is blood and the first pump is a blood pump (9) predisposed for circulation of blood in the extracorporeal circuit.

8. The apparatus of claim 1, wherein:

- the extracorporeal circuit is connected to a first chamber (2) of a blood treatment unit (1) having a second chamber (3) separated from the first chamber (2) by a semipermeable membrane (4), the second chamber (3) having an outlet which is connected to a drainage line (15) for a discharge fluid;
- the first pump is a drainage pump (16) predisposed for

circulation of the discharge fluid in the drainage line (15), the fluid is the discharge fluid, and the fluid transport line cooperating with the extracorporeal circuit is the drainage line (15).

9. The apparatus of claim 1, wherein the control and calculation unit (17) is programmed for:

- receiving signals corresponding to the values assumed by the blood characteristic at at least two different zones of the blood circulation path and for at least two different values of the flow rate of the first pump (9; 16);
- storing in memory said values of the blood characteristic and the corresponding values of the flow rate of the first pump (9; 16);
- processing said values stored in the memory using the mathematical model for determining at least one value of the vascular access characteristic.

10. The apparatus of claim 1, comprising at least a second pump (9, 16) predisposed for circulation of a fluid in another of either the extracorporeal blood circuit or the fluid transport line (15) cooperating with the extracorporeal blood circuit, the mathematical model of the vascular access (6) comprising at least a fourth parameter relative to the flow rate (q_b, q_{uf}) of the fluid made to circulate in the second pump.

11. The apparatus of claim 10, wherein the unit of control and calculation (17) is connected to the second pump (9; 16), and wherein the monitoring procedure further comprises the following stages:

- varying the flow rate of the second pump (9; 16);
- receiving signals corresponding to the values assumed by the blood characteristic at at least one zone of the blood

circulation path and for at least two different values of the flow rate of the second pump (9; 16);

- storing in the memory said values of the blood characteristic and the corresponding values of the second pump (9; 16);
- processing said stored values using the mathematical model for determining at least one value of the vascular access characteristic.

12. The apparatus of claim 10, wherein the unit of control and calculation (17) is programmed for:

- receiving signals corresponding to the values assumed by the blood characteristic at at least two different zones of the blood circulation path and for at least two different values of the flow rate of the second pump (9; 16);
- storing in the memory said values of the blood characteristic and the corresponding flow rate values of the second pump (9; 16);
- processing said stored values using the mathematical model for determining at least one value of the vascular access characteristic.

13. The apparatus of claim 10, wherein the unit of control and calculation (17) is programmed to receive at least two signals, for at least two different values of the flow rate of the first pump and a same value of the flow rate of the second pump.

14. The apparatus of claim 10, wherein the unit of control and calculation is programmed to receive at least two signals, for at least two different values of the flow rate of the second pump and a same value of the flow rate of the first pump.

15. The apparatus of claim 10, wherein the unit of control and

calculation is programmed to maintain the flow rate of the second pump constant during the variation in flow rate of the first pump.

16. The apparatus of claim 11, in which the unit of control and calculation is programmed to maintain the flow rate of the first pump constant during the variation in flow rate of the second pump.

17. The apparatus of claim 1, wherein:

- the mathematical model comprises at least one parameter relating to at least one characteristic (P_a, P_v) of the systemic circulation of a patient;
- the unit of control and calculation (17) is predisposed to receive at least one signal corresponding to the said characteristic (P_a, P_v).

18. The apparatus of claim 17, wherein the characteristic of the systemic circulation of the patient is the systemic arterial pressure (P_a).

19. The apparatus of claim 1, wherein the extracorporeal blood circuit (5, 10) is connected to the vascular access in a blood withdrawal zone and in a blood return zone.

20. The apparatus of claim 19, wherein the unit of control and calculation (17) is connected to at least a first sensor (8) predisposed to detect at least one value of the blood characteristic in a zone which is comprised between the blood withdrawal zone and a blood pump (9), the said zone of the value detection also including the blood withdrawal zone, the unit of control and calculation (17) also emitting a signal corresponding to the value detected.

21. The apparatus of claim 20, wherein the first sensor (8) is a pressure sensor.

22. The apparatus of claim 20, wherein the first sensor (8) is

predisposed to operate in the extracorporeal circuit (5, 10) upstream of the blood pump (9).

23. The apparatus of claim 20, wherein the first sensor is predisposed to operate in the blood withdrawal zone of the vascular access.

24. The apparatus of claim 20, wherein the unit of control and calculation (17) is connected to at least a second sensor (12) predisposed to detect at least one value of the blood characteristic in a zone comprised between the blood pump (9) and the blood return zone, the blood return zone being included in the said detection zone; the second sensor emitting a signal giving the value detected.

25. The apparatus of claim 24, wherein the second sensor (12) is a pressure sensor.

26. The apparatus of claim 24, wherein the second sensor (12) is predisposed to operate in the extracorporeal circuit downstream of a blood treatment unit (1).

27. The apparatus of claim 25, wherein the second sensor is predisposed to operate in the blood return zone of the vascular access.

28. The apparatus of claim 1, wherein the second parameter relating to at least one blood characteristic is a parameter relating to blood pressure.

29. The apparatus of claim 28, wherein the second parameter is a parameter relating to the blood pressure in a blood withdrawal zone of the vascular access (6).

30. The apparatus of claim 28, wherein the second parameter is a parameter relating to the blood pressure in a blood return zone of the vascular access (6).

31. The apparatus of claim 1, wherein the mathematical model contained in the memory describes a pressure variation in

the vascular access (6) as a function of the blood flow rate.

32. The apparatus of claim 1, wherein the first parameter is chosen in a group comprising the parameters relating to one or more of the following characteristics of the vascular access (6): the blood flow rate (q_a) upstream of a blood withdrawal zone of the vascular access (6); the blood flow rate (q_f) between the blood withdrawal zone and a blood return zone to the vascular access (6); the blood flow rate (q_v) downstream of the blood return zone; vascular hydraulic resistance (R_d) upstream of the blood withdrawal zone; vascular hydraulic resistance (R_f) between the blood withdrawal zone and the blood return zone; vascular hydraulic resistance (R_v) downstream of the blood return zone.

33. The apparatus of claim 1, wherein the mathematical model comprises one or more of the following equations:

$$q_a = \frac{P_a - P_{af}}{R_d}$$

$$P_{af} - P_{vf} = R_f \cdot (q_a - q_b)$$

$$P_{vf} - P_v = R_v \cdot (q_a - q_{uf}).$$

34. The apparatus of claim 1, wherein the unit of control and calculation (17) is predisposed to receive the signals corresponding to values for the blood characteristic in at least a first detection zone of the extracorporeal circuit which is distant from a blood withdrawal zone from the vascular access (6).

35. The apparatus of claim 34, wherein the memory contains a second mathematical model of the variation of the blood characteristic between the blood withdrawal zone and the first detection zone; the unit of control and calculation

(17) being programmed to process, using the second mathematical model, the values of the blood characteristic relating to the first detection zone, and to determine at least one value of the blood characteristic which relates to the blood withdrawal zone.

36. The apparatus of claim 1, wherein the unit of control and calculation (17) is predisposed to receive the signals corresponding to the values of the blood characteristic in at least a second detection zone of the extracorporeal circuit, distant from a blood return zone of the vascular access (6).

37. The apparatus of claim 36, wherein the memory contains a third mathematical model for the variation of the blood characteristic between the blood return zone and the second detection zone; the unit of control and calculation (17) being programmed to process, using the third mathematical model, the values of the blood characteristic relating to the second detection zone, and to determine at least one value of the blood characteristic which relates to the blood return zone.

38. The apparatus of claim 37, wherein at least one of the second and third mathematical models comprises at least one parameter relating to the blood flow rate.

39. The apparatus of claim 37, wherein at least one of the second and third mathematical models comprises at least one parameter relating to hematocrit of the blood.

40. The apparatus of claim 37, wherein:

- at least one of the second and third mathematical models comprises at least one series of experimentally-determined coefficients which are characteristic of an access tool (N_A, N_V) used for connecting the extracorporeal circuit with the

vascular access (6) during a blood withdrawal or return stage;

- the memory contains coefficients which are characteristic of a plurality of access tools (N_A, N_V) of different types and is predisposed to recognise a type of access tool used time-by-time and to use, in at least one of the second and third mathematical models, the coefficients which are characteristic of the type of access tool recognised.

41. The apparatus of claim 1, comprising at least one device, of known type, connected to the unit of control and calculation (17), predisposed to emit a signal indicating the flow rate of the fluid sent in circulation by the first pump.

42. The apparatus of claim 1, wherein the unit of control and calculation (17) is programmed for:

- receiving, at regular intervals, the signals relating to the values of the blood characteristics in at least one zone of the blood circulation path during the variation of flow rate of the first pump (9; 16);
- evaluating the changes in the values;
- using the blood characteristic values for a following processing operation when the variation has exceeded a threshold value.

43. The apparatus of claim 1, wherein the unit of control and calculation (17) is programmed to:

- receive, at regular intervals, the signals relating to the values of the blood characteristic in at least two different zones of the blood circulation path during the variation of flow rate of the first pump (9; 16);
- calculate the difference between the change of the blood characteristic detected in a first zone of the blood

circulation path and the change of the blood characteristic detected in a second zone of the blood circulation path;

- use for the subsequent processing the values of the blood characteristic when the difference has exceeded a threshold value.

44. The apparatus of claim 42, wherein the blood characteristic is the blood pressure and the threshold value is about 2 mmHg.

45. The apparatus of claim 1, wherein the unit of control and calculation (17) is programmed to:

- reach a steady state after having maintained the flow rate of each pump at a constant rate for a determined period of time;
- store and process values of the blood characteristic in the steady state.

46. The apparatus of claim 10, wherein the unit of control and calculation (17) is programmed to perform a monitoring procedure which comprises the following operative stages:

- changing the flow rate of the first pump;
- changing the flow rate of the second pump;
- receiving signals relating to the values of the blood characteristic in at least one zone of the blood circulation path, for at least two different values of the first pump flow rate and for at least two different values of the second pump flow rate;
- storing said values of the blood characteristic and the corresponding values of the first pump flow rate and the second pump flow rate;
- processing said values stored by means of the mathematical model to determine at least one value of the vascular access characteristic.

47. A machine for treatment of blood in an extracorporeal circuit, comprising a monitoring apparatus according to any one of claims from 1 to 46.

48. The machine of claim 47, predisposed to perform one or more of the following treatments:

- hemodialysis;
- hemofiltration;
- hemodiafiltration;
- pure ultrafiltration;
- plasmapheresis.

49. The machine of claim 47, comprising a timer connected to the unit of control and calculation (17), the unit of control and calculation (17) being able to perform the monitoring procedure at least once during the extracorporeal treatment.

50. The machine of claim 47, wherein the unit of control and calculation (17) is predisposed to operate selectively in at least two operative modes:

- a first operative mode in which the monitoring procedure is started up by command of an operator;
- a second operative mode in which the monitoring procedure is started up automatically at a predetermined moment during the treatment.

51. A method for monitoring a vascular access of an extracorporeal blood circuit, comprising the stages of:

- storing in memory at least one mathematical model of the vascular access;
- varying the flow rate of at least one fluid running in at least one of the extracorporeal blood circuit (5, 10) and the at least one fluid line (15) cooperating with the extracorporeal blood circuit (15);

- determining the values of at least one blood characteristic (P) in at least one zone of the blood circulation path and at at least two different values of the flow rate of the fluid;
- storing in memory said values of the blood characteristic and the corresponding values of the flow rate of the fluid;
- determining at least one value of a characteristic (R_d, R_f, R_v, q_a, q_f, q_v) of the vascular access by means of the mathematical model and the stored values.

52. The method of claim 51, wherein the mathematical model of the vascular access comprises:

- at least a first parameter relating to the characteristic (R_d, R_f, R_v, q_a, q_f, q_v) of the vascular access;
- at least a second parameter relating to the blood characteristic (P); and
- at least a third parameter relating to the flow rate (q_b, q_{uf}) of the fluid running in at least one of the extracorporeal blood circuit (5, 10) and the line (15) cooperating with the extracorporeal blood circuit.

53. The method of claim 51, wherein the stage of determining the values of a blood characteristic comprises the following sub-stages:

- determining the values of the blood characteristic in at least a first zone of the blood circulation path and for at least two different values of the flow rate of the fluid;
- determining the values of the blood characteristic in at least a second zone of the blood circulation path which is distant from the first zone, and for at least two different values of the flow rate of the fluid.

54. The method of claim 53, wherein the said at least two different values of the flow rate of the fluid by which the

values of the blood characteristic in the first zone are determined are equal to the said two values of the flow rate by which the values of the blood characteristic in the second zone are determined.

55. The method of claim 51, wherein:

- the said stage of variation of the flow rate of at least one fluid comprises the sub-stages of:
  - o varying the flow rate of a first fluid running in the extracorporeal circuit (5; 10), and
  - o varying the flow rate of a second fluid running in a line (15) connected to the extracorporeal circuit (5; 10);
- the said stage of determining the values of at least one blood characteristic consists in determining the said values in at least one zone of the blood circulation path, and at at least two different flow rate values of the first fluid, and at at least two different flow rate values of the second fluid.

56. The method of claim 51, wherein the said stage of varying the flow rate of at least one fluid consists in varying the blood flow rate in the extracorporeal circuit (5; 10).

57. The method of claim 51, wherein the values of the blood characteristic are determined in at least two different zones of the blood circulation path.

58. The method of claim 51, wherein the said stage of varying the flow rate of at least one fluid consists in varying a flow rate of a discharge fluid running in a drainage line (15) connected to the extracorporeal circuit (5; 10) by means of a semi-permeable membrane (4).

59. The method of claim 51, wherein the stage of varying the flow rate of at least one fluid consists in varying the

blood flow rate in the extracorporeal circuit (5; 10), and in varying the flow rate of a discharge fluid running in a drainage line (15) connected to the extracorporeal circuit by means of a semi-permeable membrane (4).

60. The method of claim 51, wherein the mathematical model comprises at least one parameter relating to at least one characteristic (P_a, P_v) of the systemic circulation of the patient.

61. The method of claim 60, comprising a stage of determining at least one value for the said at least one characteristic (P_a, P_v) of the systemic circulation of the patient, a stage of storing the said at least one value and a stage of using the said at least one value for determining the characteristic of the vascular access (6).

62. The method of claim 60, wherein the said characteristic of the systemic circulation system of the patient is the systemic arterial pressure (P_a).

63. A method for monitoring a vascular access of an extracorporeal blood circuit, wherein the extracorporeal blood circuit (5; 10) is connected to a first chamber (2) of a blood treatment unit (1) having a second chamber (3) which is separated from the first chamber (2) by a semi-permeable membrane (4), and which is provided with an outlet connected to a drainage line (15) of a discharge fluid, the method comprising the stages of:

- storing in memory a mathematical model of the vascular access (6);
- varying the flow rate of the discharge fluid in the drainage line (15);
- determining the values of a blood characteristic in at least one zone of the blood circulation path and at at

least two different values of the discharge fluid flow rate;

- storing in memory the said values of the blood characteristic and the corresponding values of the discharge fluid flow rate;
- determining at least one value of the vascular access characteristic using the mathematical model and the said stored values.

64. The method of claim 63, wherein the values of the blood characteristic are determined in at least two different zones of the blood circulation path.

65. A method for monitoring a vascular access of an extracorporeal blood circuit, wherein the extracorporeal blood circuit (5; 10) is connected to a first chamber (2) of a blood treatment unit (1) having a second chamber (3) which is separated from the first chamber (2) by a semi-permeable membrane (4), and which is provided with an outlet connected to a drainage line (15) of a discharge fluid, the method comprising the stages of:

- storing in memory a mathematical model of the vascular access (6);
- varying the flow rate of the discharge fluid in the drainage line (15);
- varying the blood flow rate in the extracorporeal blood circuit;
- determining the values of a blood characteristic in at least one zone of the blood circulation path and at at least two different values of the discharge fluid flow rate and at at least two different values of the blood flow rate;
- storing in memory the said values of the blood

characteristic and the corresponding values of the discharge fluid flow rate and the blood flow rate;

- determining at least one value of the vascular access characteristic using the said mathematical model and the said stored values.

66. The method of claim 56, wherein the discharge fluid is a product of ultrafiltration which passes across the semi-permeable membrane (4).

67. The method of claim 56, wherein the blood characteristic is determined at at least two different values of the discharge fluid flow rate, and at a same value of the blood flow rate.

68. The method of claim 57, wherein the blood characteristic is determined at at least two different values of the blood flow rate, and at a same value of the discharge fluid flow rate, and at at least two different values of the discharge fluid flow rate, and at a same value of the blood flow rate.

69. The method of claim 56, wherein the blood flow rate is maintained constant during the variation of the discharge fluid flow rate.

70. The method of claim 57, wherein the discharge fluid flow rate is maintained constant during the variation of the blood flow rate.

71. The method of claim 52, wherein the mathematical model of the vascular access (6) comprises at least a fourth parameter relating to the flow rate (q_b, q_{uf}) of a fluid which runs in one or another of the extracorporeal blood circuit (5; 10) and the drainage line (15) cooperating with the extracorporeal blood circuit (5; 10).

72. The method of claim 52, wherein the second parameter

relates to a physical or chemical or physical-chemical property of the blood, which property has a correlation with the blood flow rate, the mathematical model being a model describing the correlation.

73. The method of claim 72, wherein the blood property is the blood pressure.

74. The method of claim 52, wherein the first parameter relates to at least one fluid-dynamic characteristic of the vascular access (6), the mathematical model being a fluid-dynamic model of the vascular access (6).

75. The method of claim 51, wherein the extracorporeal blood circuit comprises a blood withdrawal line (5), connected to a blood withdrawal zone of the vascular access (6) of a patient, and a blood return line (10), connected to a blood return zone of the vascular access (6).

76. The method of claim 75, wherein the value of the blood characteristic is determined by measurement thereof in a zone of the extracorporeal blood circuit located downstream of the blood withdrawal zone.

77. The method of claim 75, wherein a blood pump (9) operates in the extracorporeal blood circuit to cause the blood to circulate, and wherein the measurement is taken upstream of the blood pump (9).

78. The method of claim 75, wherein the value of the blood characteristic is determined by measurement thereof in the blood withdrawal zone of the vascular access (6).

79. The method of claim 75, wherein the value of the blood characteristic is determined by measurement thereof in a zone of the extracorporeal blood circuit which is upstream of the blood return zone.

80. The method of claim 75, wherein the value of the blood

characteristic is determined by measurement thereof in the blood return zone of the vascular access.

81. The method of claim 51, wherein a blood treatment unit (1) operates in the extracorporeal blood circuit, and wherein the value of the blood characteristic is determined by measurement performed downstream of the blood treatment unit (1).

82. The method of claim 51, wherein the mathematical model stored in the memory is a mathematical model of a change in pressure in the vascular access as a function of the blood flow rate.

83. The method of claim 52, wherein the first parameter is chosen from the parameters relating to one or more of the following characteristics of the vascular access (6): the blood flow rate (q_a) upstream of a blood withdrawal zone from the vascular access (6); the blood flow rate (q_f) between the blood withdrawal zone and a blood return zone at the vascular access (6); the blood flow rate (q_v) downstream of the blood return zone; the vascular hydraulic resistance (R_d) upstream of the blood withdrawal zone; the vascular hydraulic resistance (R_f) between the blood withdrawal zone and the blood return zone; the vascular hydraulic resistance (R_v) downstream of the blood return zone.

84. The method of claim 51, wherein the mathematical model comprises one or more of the following equations:

$$q_a = \frac{P_a - P_{af}}{R_d}$$

$$P_{af} - P_{vf} = R_f \cdot (q_a - q_b)$$

$$P_{vf} - P_v = R_v \cdot (q_a - q_{uf}).$$

85. The method of claim 51, wherein the value of the blood

characteristic is determined by measuring in the extracorporeal circuit in at least a first detection zone, distant from a blood withdrawal zone at the vascular access (6).

86. The method of claim 85, wherein the memory contains a second mathematical model of the variation in the blood characteristic between the blood withdrawal zone and the first detection zone; the second mathematical model being used to determine at least one value of the blood characteristic relating to the blood withdrawal zone.

87. The method of claim 51, wherein the said value of the said blood characteristic is determined by measurement in the extracorporeal circuit (5; 10) in at least a second detection zone, distant from the blood return zone to the vascular access (6).

88. The method of claim 87, wherein the memory contains a third mathematical model of the variation in the said blood characteristic between the blood return zone and the second detection zone; the second mathematical model being used to determine at least one value of the said blood characteristic relating to the blood return zone.

89. The method of claim 86, wherein at least one of the second mathematical model and the third mathematical model comprises at least one parameter relating to the blood flow rate.

90. The method of claim 86, wherein at least one of the second mathematical model and the third mathematical model comprises at least one parameter relating to the blood hematocrit.

91. The method of claim 51, comprising operations of:

- determining at regular intervals the values of the said

blood characteristic in at least one zone of the blood circulation path during at least one flow rate variation;

- evaluating the variation in the said values;
- using, in determining at least one value of the said characteristic of the vascular access, the values of the said blood characteristic when the said variation exceeds a threshold value.

92. The method of claim 51, comprising operations of:

- determining at regular intervals the values of the said blood characteristic in at least two different zones of the blood circulation path during at least one flow rate variation;
- calculating the difference between the variation of the said blood characteristic detected in a first zone of the blood circulation path and the variation of the said blood characteristic detected in a second zone of the blood circulation path;
- using, in determining at least one value of the said characteristic of the vascular access, the values of the said blood characteristic when the said difference has exceeded a threshold value.

93. The method of claim 91, wherein the said blood characteristic is the blood pressure and the threshold value is about 2 mmHg.

94. The method of claim 51, comprising the stages of:

- reaching a steady state after having maintained each flow rate constant for a determined period of time;
- storing and processing the values of the said blood characteristic in the said steady state.

95. A method for operating a blood treatment machine for determining hemodynamic parameters during extracorporeal

blood treatment, wherein blood is sent to a blood treatment unit (2, 3, 4) via an arterial line (5) of an extracorporeal blood circuit which is connected with a vascular access (6), and is returned via a venous line (10) of the extracorporeal blood circuit; at least a pump (9, 16) being predisposed for circulation of a fluid in at least one of the extracorporeal blood circuit and an at least one fluid transport line (15) cooperating with the circuit, the method comprising the stages of:

- varying the flow rate of the said pump (9; 16);
- determining the values (P_{af}, P_{am}, P_{vf}, P_{vm}) assumed by a characteristic (P) of the blood in at least one zone of the blood circulation path and with at least two different values of the flow rate (q_b, q_{uf}) of the pump (9; 16);
- storing in memory the said values of the characteristic (P) of the blood and the corresponding values of the flow rate of the pump (9; 16);
- processing the said values stored in memory by calculating at least one solution of a mathematical model, in order to determine at least one value of at least one characteristic (R_d, R_f, R_v, q_a, q_f, q_v) of the vascular access, the mathematical model describing a relationship between the difference of the said characteristic (P) of the blood at two points of the intracorporeal blood circulation path and the blood flow rate (q_a, q_f, q_v) flowing between the said two points.

96. The method of claim 95, wherein the said mathematical model comprises:

- at least a first parameter relating to the said characteristic (R_d, R_f, R_v, q_a, q_f, q_v) of the vascular access;

- at least a second parameter relating to the said characteristic (P) of the blood; and
- at least a third parameter relating to a flow rate (q_b, q_{uf}) of the fluid sent in circulation by the pump (9; 16).

97. The method of claim 95, wherein the said blood characteristic (P) is the blood pressure.

98. The method of claim 95, wherein the number of the said processed values is greater than two and the said at least one solution of the mathematical model is the optimal solution.